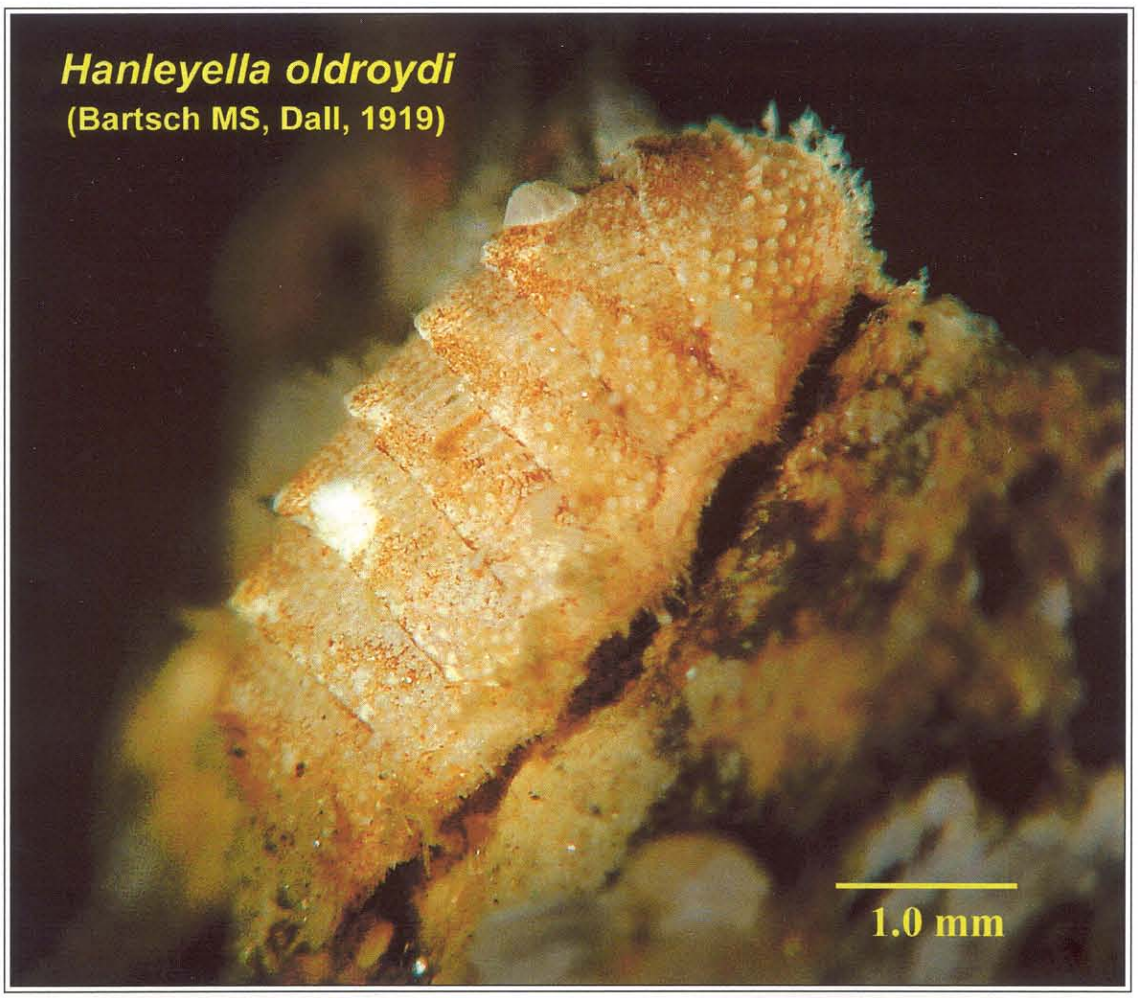
THE CITY OF SAN DIEGO

EMTS Division Laboratory Quality Assurance Report 2004



City of San Diego
Ocean Monitoring Program

Metropolitan Wastewater Department
Environmental Monitoring and Technical Services Division

EMTS DIVISION LABORATORY QUALITY ASSURANCE REPORT

Prepared by
City of San Diego
Ocean Monitoring Program
Metropolitan Wastewater Department
Environmental Monitoring & Technical Services Division

April 2005

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Acknowledgments: We are grateful to the personnel of the City's Marine Biology and Marine Microbiology laboratories for their assistance in the collection and processing of all samples.

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SUMMARY AND OVERVIEW OF WORK PERFORMED IN 2004

The Environmental Monitoring and Technical Services (EMTS) Division Laboratory, Metropolitan Wastewater Department, City of San Diego performs effluent, influent, and groundwater testing and receiving waters monitoring according to NPDES permit requirements for the City of San Diego E.W. Blom, Point Loma Wastewater Treatment Plant (PLWTP), South Bay Water Reclamation Plant (SBWRP), and International Water and Boundary Commission International Wastewater Treatment Plant (IWTP). A total of 8257 discrete samples were collected by the Laboratory in 2004. Of these, 923 (11%) were quality control (QC) samples, such as field duplicate samples (see Table 3). In addition, a number of quality assurance (QA) procedures for infaunal identifications (i.e., resort and re-identifications), microbiological analyses (i.e., split samples), and toxicology (i.e., reference toxicant and control water samples) were also conducted. These QA/QA procedures were used to support the accuracy, precision, and performance of the resultant data.

The comprehensive QA/QC activities of the Laboratory are documented separately in the Laboratory's Quality Assurance Plan (City of San Diego in prep). Additionally, the EMTS Division maintains International Standards Organization (ISO) 14001 Environmental Management Systems certification. As part of the ongoing certification process, the Division underwent and passed an annual audit by the third-party Environmental Management standards.

The following report summarizes the QA/QC activities during 2004 which were used to validate the data used in NPDES and other permit monitoring or environmental testing and reporting.

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General Introduction

Environmental Monitoring & Technical ServicesDivision Laboratory
Metropolitan Wastewater Department
City of San Diego

INTRODUCTION

The Quality Assurance/Quality Control Program for the Environmental Monitoring and Technical Services (EMTS) Division Laboratory, Metropolitan Wastewater Department (MWWD), City of San Diego includes various practices that have been instituted to ensure the accuracy and reliability of monitoring data reported to regulatory agencies in response to the reporting requirements of several National Pollutant Discharge Elimination System (NPDES) permits (**Table 1**). These QA/QC procedures assure the quality of field sampling, laboratory analysis, records keeping, data entry, electronic data collection/transfer, as well as data analysis and reporting. The procedures are regularly reviewed and updated to reflect ongoing changes in NPDES permit requirements, sample collection, methods, technology, and applicability of new analytical methods. Documents describing these and other procedures are maintained in accordance with EMTS Division Laboratory Quality Assurance Plan (in prep) and (MWWD-EMTS) ISO 14001 certification.

This report provides the results of the QA procedures conducted in 2004 which were performed in support of the permit mandated work conducted by the EMTS Laboratory in accordance the applicable NPDES Permits listed in Table 1.

Table 1

National Pollutant Discharge Elimination Systems (NPDES) permits subject to receiving waters monitoring by the EMTS Division laboratories.

Facility	Owner/Operator	NPDES Permit No	Effective Date	Comment
E.W. Blom Point Loma Wastewater Treatment Plant	City of San Diego	CA0107409, Order No. R9-2002-0025	October 16, 2000	Addendum No. 1 adopted on June 11, 2003, with an effective date of August 1, 2003
South Bay Water Reclamation Plant	City of San Diego	CA0109045, Order No. 2000-129	September 13, 2000	
International Wastewater Treatment Plant	International Boundary and Water Commission	CA0108928, Order No. 96-50	November 14, 1996	

FACILITIES AND STAFF

The EMTS Division includes three laboratories that participate in the receiving waters monitoring activities associated with the above NPDES permits: (1) Marine Biology and Ocean Operations; (2) Marine Microbiology and Vector Management; and (3) Wastewater Chemistry Laboratory. The Marine Biology and Marine Microbiology laboratories are responsible for conducting the receiving waters monitoring activities. Laboratory personnel are organized into technical work groups based on their major work responsibilities and areas of expertise. Brief descriptions of the areas of emphasis for each work group are given below. Detailed descriptions

of the Marine Biology and Marine Microbiology laboratory organization, personnel, and personnel classifications are provided in the EMTS Laboratory QA Plan. Additional quality assurance procedures conducted by the Wastewater Chemistry Laboratory are presented in a separate report (e.g., City of San Diego 2003).

Marine Biology and Ocean Operations

Data Management and Reporting Group: The primary responsibility of the DM&R Group is the analysis and reporting of receiving waters monitoring data. This work includes data QA, data analysis, and the interpretation of results from the receiving waters monitoring activities and other contract work. DM&R personnel work together with the IT/GIS Systems Group (described below) to perform QA of all receiving waters monitoring data that is entered into the laboratory's database. Various software packages for data management (e.g., Oracle, Access), manipulations (e.g., Excel), statistical analysis (e.g., SAS, PRIMER), and presentation (e.g., Sigma Plot, Microsoft PowerPoint) are used to manage, manipulate, and analyze data from every aspect of receiving waters monitoring. The interpretation of these analyses are reported to regulatory and contract agencies in the form of monthly, quarterly, semiannual, and annual reports.

Information Technology and GIS Systems Group: The IT/GIS Systems Group is primarily responsible for the administration of the lab's database and the analysis of spatial data. Daily responsibilities for the IT/GIS group include the entry and archiving of sampling data, validation of data accuracy, the database structure and integrity, oversight of database access/security issues as well as enhancements to the database structure, and project planning/application development to support the needs of EMTS lab staff. This group is also responsible for timely and accurate data entry, spatial data analysis, GIS map preparation, and the assembly and publication of reports.

Ocean Operations and Toxicology Group: This group is comprised of three subsections, Ocean Operations, Vessel Operations, and Toxicology. The Ocean Operations section oversee and conduct water quality sampling, benthic sediment chemistry and infauna sampling, trawl, long-line, and diving operations, and remotely operated vehicle (ROV) inspections of the ocean outfalls. They also maintain and calibrate all oceanographic instrumentation, including SCUBA equipment and the ROV. The Vessel Operations section is responsible for the operation and maintenance of the City's two oceanographic survey vessels, the 42' *Monitor III* and the 30' *Metro*. When in port, the Boat Operators schedule and oversee all of the regular vessel maintenance as well as any modifications that may become necessary. While at sea, they are responsible for ensuring the safety of the crew and for accurately locating and maintaining position at the sampling stations, and assist with various deck activities during a variety of sampling operations. The Toxicology section is primarily responsible for coordinating sample collection and for conducting the required chronic and acute toxicity testing as required by the City's NPDES permits. The Toxicity Laboratory is certified from the State of California Department of Health Services, Environmental Laboratory Accreditation Program (ELAP), which is renewed on a bi-annual basis. The current certification is scheduled for renewal on April 30, 2006 (**Table 2**).

Taxonomy Group: This group coordinates and manages the processing of all benthic infauna and trawl invertebrate samples, maintains the taxonomic literature and voucher collections, and conducts taxonomic training. In addition, they produce in-house species identification sheets and keys. Members of this group also participate in a regional taxonomic standardization program and perform all QA/QC procedures to ensure the accuracy of all taxonomic identifications made by laboratory personnel.

Marine Microbiology and Vector Management

Marine Microbiology Group: The Marine Microbiology technical staff prepare and sterilize microbiological media, reagents, sample bottles, supplies and equipment. They also collect field samples and transport them to the laboratory for analysis. Professional staff perform a variety of analyses (e.g., membrane filtration, multiple tube fermentation, and Colilert-18 and Enterolert chromogenic substrate analyses) as appropriate to the sample type and as required by the NPDES permits. The group is responsible for the physical maintenance and quality assurance of large instruments such as autoclaves, incubators, water baths, ultra-freezers, bacteriological safety cabinet and three reagent grade water point-of-use systems. Members are also responsible for developing sampling, analytical, and quality assurance protocols for special projects or studies involving microbiology. The Marine Microbiology Laboratory presently receives certification from the State of California Department of Health Services. Certification is approved as per the Environmental Laboratory Accreditation Program (ELAP) and consists of lab audits and proficiency testing. The current certification is in effect until November 30, 2006 (Table 2).

Vector Management Group: Vector Management provides for monitoring, surveillance, control and prevention of insects and other pests that are capable of transmitting diseases or causing harm to humans. The primary methods of control include environmental conservation measures, education, and water management techniques aided by appropriate chemical and biological control technology. The vector control program uses methods to census animal populations to determine control effectiveness and trends. Areas of responsibility include Metropolitan Wastewater Department treatment plants, pump stations, buildings and office facilities. Biological assessment (bioassessment) of urban creeks and streams are conducted to evaluate and analyze short and long term impacts of sewage spills into watersheds and receiving waters. Field samples of aquatic communities are collected and field water quality indicators are measured. Physical habitat characteristics and anthropogenic changes are evaluated. Measures, evaluations, and comparisons are made to yield relative ratings of conditions within a specified community.

Table 2

Environmental Monitoring and Technical Services Division Laboratory ELAP certifications.

Laboratory Facility	Laboratory	Address	Phone	EPA Lab Code	ELAP Cert. No.
Environmental Monitoring & Technical Services	Marine Microbiology	2392 Kincaid Rd. San Diego, CA 92101-0811	619-758-2360	CA 01393	2185
Environmental Monitoring & Technical Services	Toxicity	2392 Kincaid Rd. San Diego, CA 92101-0811	619-758-2348	CA 01302	1989

SCOPE OF WORK

Treated effluent from the City of San Diego E.W. Blom Point Loma Wastewater Treatment Plant (PLWTP) is discharged to the Pacific Ocean through the Point Loma Ocean Outfall (PLOO). The South Bay Ocean Outfall (SBOO) accepts treated effluent from two sources: the International Boundary and Water Commission International Wastewater Treatment Plant (IWTP), and the City of San Diego South Bay Water Reclamation Plant (SBWRP). The NPDES permits associated with each of these outfalls define the requirements for toxicity testing of plant operations and monitoring of receiving waters surrounding each discharge site.The permits define the sampling plans, compliance criteria, laboratory analyses, statistical analyses and reporting guidelines. In 2004, a total of 8257 discrete samples were collected by the EMTS Division Laboratory, including samples collected as part of the permit-mandated special studies (**Table 3**). Of these, 923 (11%) represent quality control (QC) samples such as field duplicates. In addition, 166 quality assurance (QA) procedures were also conducted to validate the quality of specific analyses (i.e., macrofaunal identifications, microbiological and toxicological analyses). The results of the QA/QC activities presented herein support the accuracy and precision of the resultant data and validate their use in permit-mandated monitoring or environmental testing and reporting.

The permit-mandated receiving waters monitoring effort is summarized in **Tables 4** and **5**. The fixed-grid sampling sites are shown in **Figure 1**. Receiving waters monitoring includes monthly seawater measurements of physical, chemical and bacteriological parameters in order to document water quality conditions in the area. Benthic sediment samples are collected semiannually to monitor macrofaunal communities and sediment conditions. Trawl surveys are performed quarterly or semiannually to monitor communities of demersal fish and large, bottom-dwelling invertebrates. Additionally, analyses of fish tissues are performed semi-annually or annually to monitor levels of chemical constituents that may have ecological or human health implications. Toxicity testing consists of acute and chronic bioassay testing of influent, effluent, and groundwater. The general, permit-required toxicity testing is outlined in **Table 6.** The results of these testing and monitoring activities are analyzed and presented in monthly, quarterly, semiannual, and annual receiving waters monitoring reports.

In addition to these efforts, special strategic process studies, as determined by the City in coordination with the Executive Officer of the RWQCB and the USEPA, were also conducted in 2004 (see City of San Diego 2004). Data for these directed studies are subject to the same QA/QC procedures as the routine monitoring data, but the projects themselves do not necessarily conform to the same analysis and reporting schedules. For example, Table 3 includes the sampling effort for the sediment mapping study conducted in 2004 (see **Appendix A**) but not the macrofaunal analyses or some of the QA procedures (e.g., re-identifications) which have yet to be completed.

Table 3

Number of discrete samples collected and analyzed by the EMTS Division Laboratory for NPDES permit-related activities during 2004.

Type of Sampling & Analyses	
Sample collection	
Macrofaunal community (# grab samples)	325
Sediment quality (# grab samples)	271
Demersal fish and megabenthic invertebrate community (# otter trawl hauls)	40
Bioaccumulation – fish muscle and liver tissues (# composite samples collected) [1]	93
Water quality – CTD casts (# casts)	1236
Water quality – seawater (# samples)	6036
Toxicology (# samples)	256
Summary of analyses performed	
Macrofaunal community (# species / # identified) [2]	864 / 44,468
Sediment quality – grain size (# sub-samples)	271
Sediment quality – chemistry (# sub-samples) [3]	944
Otter trawl – demersal fish identification (# species / # identified)	53 / 10,862
Otter trawl – megabenthic invertebrate identification (# species / # identified)	93 / 19,599
Water quality – microbiology [4]	4596
Water quality – suspended solids	1104
Water quality – oil and grease	336
Toxicology – Acute bioassay (saltwater)	41
Toxicology – Chronic bioassay (saltwater)	167
Quality control samples (field duplicates)	
Sediment grain size	25
Sediment chemistry	211
Seawater samples	687
Quality assurance processes performed	
Infauna processing (# resort & re-identification samples)	20 / 7
Microbiology (split samples)	45
Acute bioassay – saltwater (reference toxicant)	31
Acute bioassay – freshwater (control water)	2
Chronic bioassay – saltwater (reference toxicant)	61

[1] Each composite tissue sample is analyzed for 4 parameter types (trace metals, chlorinated pesticides, PCBs, and PAHs) by the Wastewater Chemistry Laboratory

[2] Samples from the sediment mapping survey collected as part of a special study are not included because thier processing has not yet been completed (see Appendix A)

[3] Total number of total organic carbon, total nitrogen, BOD, total sulfides, trace metals, chlorinated pesticides, PCB, and PAH samples collected for analysis by the Wastewater Chemistry Laboratory

[4] Number of total coliform, fecal coliform, and *Enterococcus* samples analyzed.

Table 4

Receiving waters sampling effort for the Point Loma Ocean Outfall monitoring program, excluding resamples, toxicity testing, QA/QC analyses (e.g., duplicate/split samples), or special studies.

Monitoring Component	Location	No. of Sites/Zone	Sample Type	Discrete No. Samples/Site	Sampling Frequency	Sampling Times/Yr	Discrete No. Samples/Yr	Parameters	No. "Samples" Analyzed/Yr	Notes (per site/zone)
Water Quality	shore	8	Seawater - Bacti	1	weekly	52	416	T, F, E [a]	1248	1 sample
Microbiology	kelp	8	Seawater - Bacti	3	5x/month	60	1440	T, F, E [a]	4320	3 depths
		11	CTD	1	5x/month	60	480	CTD profile [c]	3840	1 cast
&	voluntary "kelp"	3	Seawater - Bacti	1	5x/month	60	180	T, F, E [a]	540	Non-NPDES, bottom depths
	offshore	3	Seawater - Bacti	3	quarterly	4	36	T, F, E [b]	108	3 depths (18-m stns)
Oceanographic	(n=36)	11	Seawater - Bacti	3	quarterly	4	132	T, F, E [b]	396	3 depths (60-m stns)
		11	Seawater - Bacti	4	quarterly	4	176	T, F, E [b]	528	4 depths (80-m stns)
Conditions		11	Seawater - Bacti	5	quarterly	4	220	T, F, E [b]	660	5 depths (98-m stns)
		36	CTD	1	quarterly	4	144	CTD profile [c]	1152	1 cast
Sediment Quality	offshore	22	Grab	1	semiannual	2	44	sediment constituents [d]	396	1 grab (Jan, Jul)
Benthic Macrofauna	offshore	22	Grab	2	semiannual	2	88	community structure	88	2 replicate grabs (Jan, Jul)
Demersal Fishes & Invertebrates	offshore	6	Trawl	1	semiannual	2	12	community structure	12	1 trawl (Jan, Jul)
Bioaccumulation	offshore	4	Trawl	9	annual	1	36	liver tissue contaminants [e]	144	composites/3 species (Oct) (6 trawl sites, 4 zones)
Fish Tissues	offshore	2	Hook & Line/Trap	3	annual	1	6	muscle tissue contaminants [f]	24	3 composites (Oct) (2 rig-fishing sites/zones)
Totals							**3,410**		**13456**	

[a] T, F, E = total coliform, fecal coliform, and enterococcus bacteria (n = 3 parameters); T, F, E = all NPDES mandated

[b] T, F, E = total coliform, fecal coliform, and enterococcus bacteria (n = 3 parameters); E = NPDES mandated, T & F = voluntary

[c] CTD profile = depth, temperature, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll a, pH, density (n = 8 parameters)

[d] Sediment constituents = sediment grain size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs, BOD (n = 9 parameter categories; see NPDES permit for complete list of constituents; BOD = voluntary)

[e] Fish tissue contaminants (liver) = lipids, PCBs, chlorinated pesticides, metals (n = 4 parameter categories; see NPDES permit for complete list of constituents); 3 metals analyzed (mercury, aresenic, selinium)

[f] Fish tissue contaminants (muscle) = lipids, PCBs, chlorinated pesticides, metals (n = 4 parameter categories; see NPDES permit for complete list of constituents); 9 metals analyzed (arsenic, cadmium, chromium, copper, lead, mercury, selenium, tin, zinc)

Table 5

Receiving waters sampling effort for the South Bay Ocean Outfall monitoring program, SBWRP and IWTP NPDES permits. Listed effort excludes resamples, toxicity testing, QA/QC analyses (e.g., duplicate/split samples), or special studies.

Monitoring Component	Location	No. of Sites/Zone	Sample Type	Discrete No. Samples/Site	Sampling Frequency	Sampling Times/Yr	Discrete No. Samples/Yr	Parameters	No. "Samples" Analyzed/Yr	Notes (per site/zone)
Water Quality	shore	11	Seawater - Bacti	1	weekly	52	572	T, F, E [a]	1716	1 sample
Microbiology	kelp	3	Seawater - Bacti	3	5x/month	60	540	T, F, E [a]	1620	3 depths
		3	CTD	1	4x/month	48	144	CTD profile 1 [b]	432	1 cast
&		3	CTD	1	1x/month	12	36	CTD profile 2 [c]	288	1 cast
	offshore	25	Seawater - Bacti	3	monthly	12	900	T, F, E [a]	2700	3 depths
Oceanographic	(n=37)	37	CTD	1	monthly	12	444	CTD profile 2 [c]	3552	1 cast
		28	TSS	3	monthly	12	1008	TSS	1008	3 depths
Conditions		28	Oil & Grease	1	monthly	12	336	O&G	336	1 depth
Sediment Quality	offshore	27	Grab	1	semiannual	2	54	sediment constituents [d]	432	1 grab (Jan, Jul)
Benthic Macrofauna	offshore	27	Grab	2	semiannual	2	108	community structure	108	2 replicate grabs (Jan, Jul)
Demersal Fishes & Invertebrates	offshore	7	Trawl	1	quarterly	4	28	community structure	28	1 trawl
Bioaccumulation	offshore	7	Trawl	3	semiannual	2	42	liver tissue contaminants [e]	210	3 composites (Apr, Oct) (trawl sites)
FishTissues	offshore	2	Hook & Line/Trap	3	semiannual	2	12	muscle tissue contaminants [e]	60	3 composites (Apr, Oct) (rig-fishing sites)
"Regional Survey"										
Sediment Quality	random array	40	Grab	1	annual	1	40	sediment constituents [d]	320	1 grab (Jul)
Benthic Macrofauna	random array	40	Grab	2	annual	1	80	community structure	80	2 replicate grabs (Jul)
Totals							**4,344**		**12,890**	

[a] T, F, E = total coliform, fecal coliform, and enterococcus bacteria (n = 3 parameters)

[b] CTD profile 1 = depth, temperature, light transmittance (transmissivity) (n = 3 parameters)

[c] CTD profile 2 = depth, temperature, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll a, pH, density (n = 8 parameters)

[d] Sediment constituents = sediment grain size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs (n = 8 parameter categories; see NPDES permit for complete list of constituents)

[e] Fish tissue contaminants = total lipids, metals, PCBs, chlorinated pesticides, PAHs (n = 5 parameter categories; see NPDES permit for complete list of constituents)

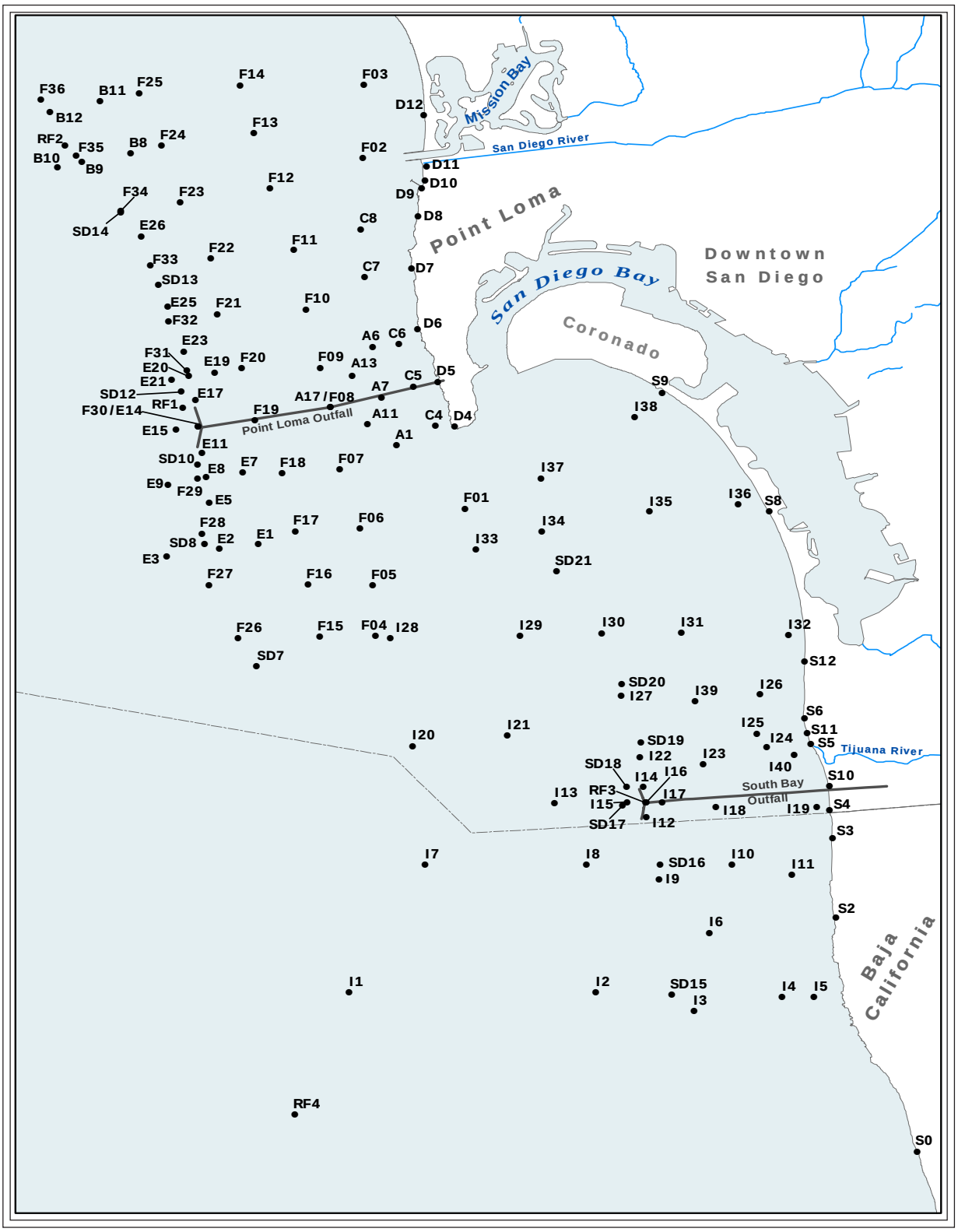

Figure 1

Receiving waters monitoring stations surrounding the Point Loma and South Bay Ocean Outfalls.

Table 6

Toxicity testing effort for the Point Loma and South Bay Ocean Outfall monitoring program, PLWWTP, SBWRP, and IWTP NPDES permits. Listed effort excludes accelerated testing requirements (e.g., triggered by Notice of Violoation), additional QA/QC procedures, or special studies.

Testing Component	Location	Sample Type	No. Samples	Sampling Frequency	Sampling Times/Yr	No. Test Species	Effluent/Ref Tox Tests/Yr	Total Tests/Yr	Endpoints	Dilutions per Bioassay	Notes
POINT LOMA											
Acute Toxicty	PLWTP	Final Effluent	1	semiannual	2	1	2 + 2 ref tox	4	survival	5 + Control	2004 species = topsmelt
	(One-time Screening)	Final Effluent	1	3 x / 2 yrs	3 x / 2 yrs	2	6+ 6 ref tox / 2 yrs	12 / 2 yrs	survival	5 + Control	screening species: mysids & topsmelt
Chronic Toxicity	PLWTP	Final Effluent	1	monthly	12	2	24 + 24 ref tox	48	sensitive lifestage	5 + Control	2004 species = red abalone & giant kelp
	(Biennial Screening)	Final Effluent	1	3 x / 2 yrs	3 x / 2 yrs	3	9+ 9 ref tox / 2 yrs	18 / 2 yrs	sensitive lifestage	5 + Control	screening species: giant kelp, red abalone, topsmelt
SOUTH BAY											
Acute Toxicty	SBWRP	Final Effluent	1	monthly	12	1	12 + 12 ref tox	24	survival	5 + Control	2004 species = topsmelt
	(Biennial Screening)	Final Effluent	1	3 x / 2 yrs	3 x / 2 yrs	2	6 + 6 ref tox / 2 yrs	12 / 2 yrs	survival	5 + Control	screening species: mysids & topsmelt
	SBWRP/IWTP	Comb. Effluent	1	quarterly	4	1	4 + 4 ref tox	8	survival	5 + Control	2004 species = topsmelt
	(Biennial Screening)	Comb. Effluent	1	3 x / 2 yrs	3 x / 2 yrs	2	6 + 6 ref tox / 2 yrs	12 / 2 yrs	survival	5 + Control	screening species: mysids & topsmelt
Chronic Toxicity	SBWRP	Final Effluent	1	monthly	12	1	12 + 12 ref tox	24	sensitive lifestage	5 + Control	2004 species = red abalone
	(Biennial Screening)	Final Effluent	1	3 x / 2 yrs	3 x / 2 yrs	3	9 + 9 ref tox / 2 yrs	18 / 2 yrs	sensitive lifestage	5 + Control	screening species: giant kelp, red abalone, topsmelt
	SBWRP/IWTP	Comb. Effluent	1	quarterly	4	1	4 + 4 ref tox	8	sensitive lifestage	5 + Control	2004 species = red abalone
	(Biennial Screening)	Comb. Effluent	1	3 x / 2 yrs	3 x / 2 yrs	3	9 + 9 ref tox / 2 yrs	18 / 2 yrs	sensitive lifestage	5 + Control	screening species: giant kelp, red abalone, topsmelt

Comb. Effluent = combined SBWRP + IWTP effluent samples

Ref Tox = Reference Toxicant Test

Sensitive lifestage endpoints: (1) red abalone = development; (2) giant kelp = germination and growth

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Results of QA/QC Activities Conducted in 2004

Example of kelp sporophyll testing

RESULTS OF QA/QC ACTIVITIES CONDUCTED IN 2004

The results of various quality assurance procedures are presented in the sections that follow. They include: (1) intercalibration of the Conductivity-Temperature-Depth (CTD) instrument used to sample water quality parameters; (2) results of the bacteriological quality assurance procedures; (3) results of the macrofaunal community sample resort and re-identification analyses; (4) results of toxicology quality assurance procedures.

CTD Intercalibration Exercise

An annual CTD intercalibration exercise is conducted in order to ensure consistency between two CTD instruments used to collect all of the permit-mandated water quality profiling data for the ocean monitoring programs. Two Sea-Bird Electronics model 25 CTD instruments were used in the intercalibration exercise for 2004. The instrument designated as Unit #3 is a combination CTD/carousel sampler and Unit #4 is a stand-alone CTD unit. The two CTD units are attached to each other and deployed together to a depth of 100 meters three times. After the three casts were completed a comparison of measurements from six sensors (temperature, salinity, dissolved oxygen, pH, fluorometer and transmissometer) and one calculated parameter (density) was performed to assess whether any observed deviations between the instruments and sensors was within acceptable limits.

The results of the intercalibration exercise are summarized in **Table 7**. Four sensors (i.e., temperature probe, salinity probe, fluorometer, transmissometer) displayed acceptable variation between instruments, while two (i.e., the DO and pH probes) showed increased variability relative to previous years that warranted review. The mean difference between both dissolved oxygen probes was 0.462 mg/L over the three casts, with a maximum value of 0.694 mg/L. Both values are higher than in past years, and exceeded the calibration criteria of +/-0.36 mg/L. The increased variance may be attributed to fouling of the polarographic membrane in the probe. Sea-Bird Electronics, the manufacturer of these DO probes, revised their recommended maintenance protocols in December 2004 after discovering that prolonged use of a solution used for degreasing and discouraging biological growth, Triton X-100, was harmful to the membrane and caused the sensor's calibration to drift. The DO probes are factory calibrated annually and calibrated monthly in-house to check for sensor drifting. At the time of the intercalibration exercise the probes on unit #3 and unit #4 had been in use for three months and one month, respectively, since the last factory calibration. The pH probes also exhibited a notable difference between instruments. The average difference was 0.055 pH units over all three casts, with a maximum difference of 0.177 pH units. Despite the increase in variability, the instruments were well within the acceptable range of (0.1 pH units). **Figure 2** depicts the results of Cast 2 only and represents an approximation of what took place during the intercalibration exercise.

Bacteriological Quality Assurance Analyses

Duplicate and split bacteriological samples were run as quality assurance checks to measure variability between samples and analyst precision, respectively. A duplicate sample was obtained by taking two distinct samples at a given station in the field and then analyzing them in exactly the same way. A split sample was obtained by taking aliquots of a single field sample and then having two different analysts perform the dilutions, filtration and

Table 7

Summary of the CTD inter-calibration casts performed during 2004. Data include mean difference, maximum difference, and the cast (i.e., 1, 2, or 3) and depth (m) at which the maximum difference occurred.

Parameter	Mean [a]	Max [a]	Cast	Depth
Temp (C)	0.054	0.473	1	22
Salinity (ppt)	0.010	0.071	1	98
DO (mg/L)	0.462	0.694	3	74
PH	0.055	0.117	2	86
XMS (%)	0.283	2.174	2	74
Density (sigma-t)	0.0127	0.0842	1	54
Fluorometer (µg/L)	0.083	0.381	1	26

plating. Duplicate samples were performed on approximately 5% of the water quality samples. Split samples were performed once each month. The sign test (see Gilbert, 1987: p242) was used to statistically compare the results of the paired duplicate and split samples collected between January and December 2004. The results of this test are summarized in **Table 8**. The raw data for these analyses have been reported previously in Monthly Receiving Waters Monitoring Reports for the Point Loma and South Bay monitoring programs.

Results from the analysis of split bacteriological samples indicate that analytical techniques were not significantly different ($p > 0.05$) among analysts for all three tested parameters (i.e., total and fecal coliforms and *Enterococcus*). However, while intra-sample variation was not significantly different for total coliform and *Enterococcus* distributions, it was significantly different for fecal coliforms ($Zb = 2.12$; $p > 0.05$). Such a result is not entirely unexpected since duplicate samples are collected in separate bottles, representing different though adjacent waters and some degree of variability between the two samples is likely.

In addition to these duplicate and split sample analyses, the Marine Microbiology and Vector Management Laboratory QA officer conducts monthly comparisons of bacterial colony counts to quantify the counting precision of each analyst and the precision counts completed by pairs of analysts. Each analyst must be able to duplicate his/her own prior colony counts within 5% and counts by any two analysts must fall within 10% of each other. In 2004, no test exceeded either measure.

Macrofaunal Community Analyses – Resort and Re-identification Analysis

The laboratory analysis of macrofaunal community samples involves three processes: sample washing and preservation, sample sorting, and organism identification and enumeration. Quality control of sorting is essential to assure the value of the subsequent steps in the sample analysis process. The sorting of benthic samples is contracted to an outside laboratory, with a 95% removal efficiency expected. Ten percent of the sorted samples are subject to resorting as QA for the contract and macrofaunal community analyses. The original sorting of a sample fails the QA criteria level if the resort has more than 5% of the total abundance of organisms from that sample. Failure to achieve 95% removal efficiency requires the re-sorting of all samples previously sorted by that technician (sorter). The resort results for the period from January and July 2004 are shown in **Table 9**. Every one of the 20 samples resorted met the 5% QA level. The percentage of animals found in the resorted samples ranged from 0 to 1.4% of the total sample abundance, and represents a marked improvement over the previous year when percentage of animals found in resorted samples ranged from 0.0 to 53.2%.

2004 CTD INTERCALIBRATION CAST

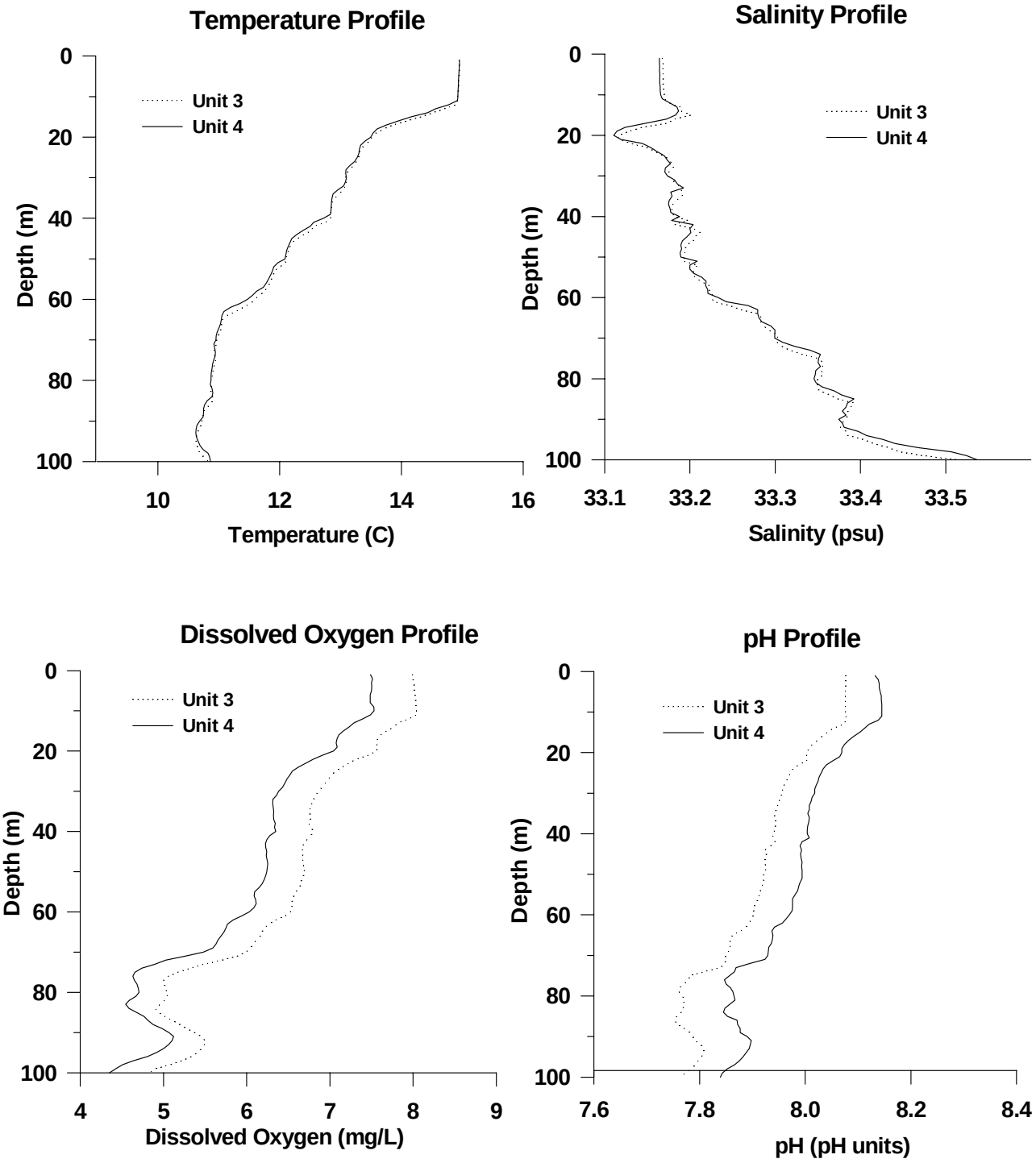

Figure 2

Example results of the 2004 CTD intercalibration casts for CTD units #3 and #4. Data includes cast profiles for temperature, salinity, dissolved oxygen, pH, transmissivity, density (sigma-t), fluorometry (before and after intercalibration).

2004 CTD INTERCALIBRATION CAST

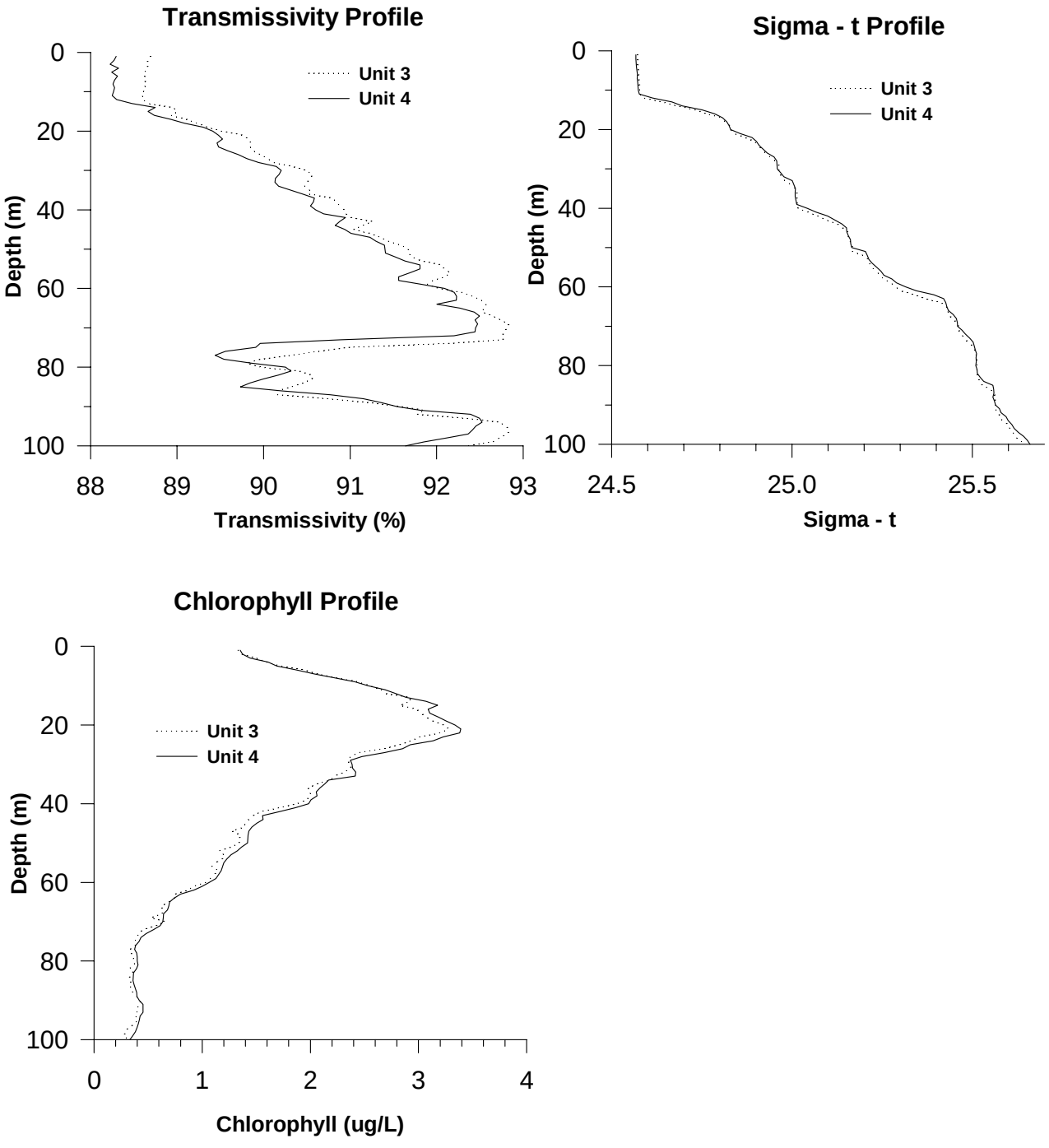

Figure 2 (*continued*)

Table 8

Summary of duplicate and split bacteriological anaylses for the Point Loma Ocean Outfall and South Bay Ocean Outfall monitoring programs conducted from January through December 2004. The paired duplicate and split samples were each compared using the sign test (see Gilbert 1987) at a p=0.05 level of significance.

Duplicate	Parameter	N	B	Zb	P	Ho
Samples	*Entero*	106	53	0.00	>0.05	ACCEPT
	Fecal	139	82	2.12	>0.05	REJECT
	Total	163	89	1.17	>0.05	ACCEPT
Split						
Samples	*Entero*	11	7	0.90	>0.05	ACCEPT
	Fecal	11	6	0.30	>0.05	ACCEPT
	Total	10	5	0.00	>0.05	ACCEPT

H_o = There is no significant difference between the samples being compared
N = number of pairs of data
B = the number of positive differences between pairs
Zb = sign test result

Table 9

Results of benthic resort analyses for the Point Loma Ocean Outfall (E and B stations) and South Bay Ocean Outfall (I stations) monitoring programs conducted during 2004. Percent = (the # of animals found in the resorted sample/the total sample abundance) X 100. [1] and [2] indicate sample replicate number.

Quarter	Station	Percent	Quarter	Station	Percent
Jan-04	B-8[2]	0.00	*Jan-04*	I-1[1]	0.00
Jan-04	E-1[1]	0.00	*Jan-04*	I-8[2]	0.00
Jan-04	E-19[1]	0.00	*Jan-04*	I-16[2]	0.00
Jan-04	E-25[1]	0.60	*Jan-04*	I-22[1]	1.45
Jan-04	E-7[1]	1.34	*Jan-04*	I-35[2]	0.00
			Jan-04	I-33[1]	0.85
Jul-04	E-5[1]	0.00	*Jul-04*	I-1[2]	0.67
Jul-04	E-20[1]	0.37	*Jul-04*	I-21[1]	0.00
Jul-04	E-17[2]	0.00	*Jul-04*	I-31[1]	0.00
Jul-04	E-23[1]	0.00	*Jul-04*	I-8[2]	0.00
			Jul-04	I-30[2]	0.00

In addition, 10% of the completed samples are typically re-identified by members of the Taxonomy Groupto assure the accuracy and consistency of the infaunal identifications conducted by all marine biologists who perform taxonomic identifications. The sample fails the QA criteria level if the original identifications deviate from the final species and abundance values by more than 10%, as determined from the re-identification process. In 2004, the number of samples subject to re-identification was reduced as a result of the laboratory's participation in the 2003 Southern California Bight regional sampling effort (Bight'03) and the 2004 sediment mapping project. The Bight'03 survey included samples collected from Ventura to San Diego, California and involved several agencies and consulting firms. As part of the Bight'03 QA/QC program for benthic identifications, seven samples identified by City marine biologists were re-identified by other agencies and

City marine biologists re-identified seven samples originally identified by other agencies. While the re-identifications have been completed, the results are pending final compilation and analysis by the participating agencies and Bight'03 Benthic Committee (see SCCWRP 2003).

Toxicology Quality Assurance Analyses

The toxicology laboratory routinely conducts reference toxicant testing as a part of the quality assurance program. A reference toxicant is a standard chemical used to measure the sensitivity of the test organisms in order to establish confidence in the toxicity data obtained from the test material. A specific reference toxicant is used for each test method, and the material is chosen from a list developed by the United States Environmental Protection Agency. Typically, the reference toxicant is purchased from a supplier in aqueous form (stock solution), and the supplier must verify the concentration of the stock solution and provide written documentation of such analysis.

In most instances, a toxicity test with a reference toxicant is performed to assess the sensitivity of the test organisms at the time the test material (e.g. effluent) is evaluated. A control chart containing no fewer than 20 of the most recent reference toxicants for each test method is maintained by the QA officer and is used to monitor test organism sensitivity. Results from a minimum of 19 of the most recent 20 reference toxicant tests must fall within the control chart boundaries (within two standard deviations of the mean). Failure to do so triggers an investigation of animal supply, reference toxicant stock quality, and laboratory practices. Additional testing will also be conducted to determine whether the exceedance is anomalous or if remedial measures are needed. All NPDES tests conducted with the affected animals will be flagged, reviewed for anomalous responses, and, in certain cases, repeated with a new batch of animals. In 2004, all reference toxicant control charts were reviewed and accepted by the State of California Environmental Laboratory Accreditation Program.

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Appendix A

Sediment Mapping Study
Conducted in 2004

San Diego Sediment Mapping Study

Workplan for Generating Scientifically Defensible Maps of Sediment Condition in the San Diego Region

Prepared by

The City of San Diego, Metropolitan Wastewater Department, Environmental Monitoring & Technical Services Division [1]

and

Southern California Coastal Water Research Project [2]

June 28, 2004

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Background

Maps are one of the best data summary tools used by managers to convey spatial extent and magnitude of environmental condition to decision makers and the public. Maps are easily displayed, self-explanatory, and give the viewer context over the entire area of interest. In addition, maps of conditions at the same location over time can generate useful assessments of trends in spatial extent (e.g., is a problem growing or shrinking?).

Although maps are useful analytical tools, the ability to create maps with scientific rigor is extremely difficult and rarely accomplished. More often, maps are generated simply using prepackaged software modules with little forethought for assessing spatial variability or describing confidence in the mapping contours. Several techniques are available for creating maps including commonly used algorithms such as linear interpolation or kriging. Linear interpolation simply uses the average between adjacent sites to estimate environmental condition from sampled to unsampled areas. Kriging offers much more sophistication using a cluster of neighboring sites to predict conditions at unsampled locations. Albeit computationally more intensive, kriging offers several advantages, the largest of which lies in its ability to create more precise estimates of condition at greater distances.

The key to effective kriging algorithms lies in the ability of mapmakers to estimate spatial variance. If the variance is large, then samples should be collected at closer distances to increase precision at unsampled locations. In contrast, if the variance is small, then samples can be spaced further apart to achieve the same precision. If the spatial variance is unknown, then the sample locations will likely be placed inefficiently. This may waste resources if samples are spaced too close together, or produce results that suffer from imprecision if samples are spaced too far apart. If the spatial variability for an area is known on the other hand, then optimal sampling distances can be selected based on the level of confidence desired by the end-user.

This workplan describes a sampling program to create maps of environmental condition with known levels of confidence. The program targets sediment quality near the City of San Diego Point Loma Ocean Outfall and the joint City/International Boundary Water Commission (IBWC) South Bay Ocean Outfall. The impetus for this study arises from the need of the City of San Diego, and its regulatory authorities the San Diego Regional Water Quality Control Board (RWQCB) and the United States Environmental Protection Agency (EPA), to have scientifically defensible maps that define sediment conditions in the region. In this case, a dedicated effort will be made to create maps of superior quality for City, IBWC, RWQCB and EPA management, as well as the public.

Specifically, the City is mandated to conduct this "special study" as part of the regulatory requirements governing the discharge of wastewater from the Point Loma Wastewater Treatment Plant (PLWTP) through the Point Loma outfall (NPDES Permit No. CA0107409, Order No. R9-2002-0025, Addendum No. 1). Such special studies, as defined by the *Model Monitoring Program for Large Ocean Discharges in Southern*

California (Schiff et al. 2001) and adopted in Order No. R9-2002-0025 for the PLWTP, are a unique mechanism to focus monitoring efforts on specific questions.

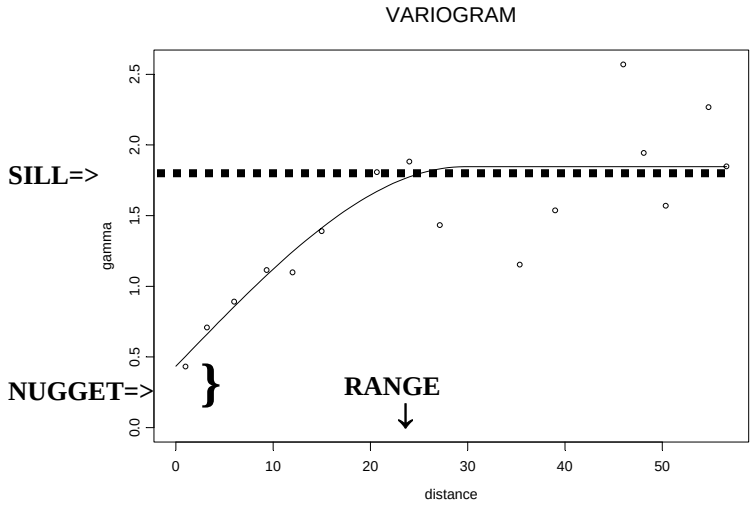
In addition to the above effort, representatives of the City, IBWC, RWQCB and EPA have negotiated a resource exchange agreement that will allow mapping of the South Bay outfall area concurrent with the Point Loma study. This resource exchange will require approval of the Executive Officer of the RWQCB for administrative modifications to the Monitoring and Reporting Programs (MRP) for the discharge of wastewater through the South Bay Ocean Outfall. Two separate NPDES permits govern this discharge, one for the City's South Bay Water Reclamation Plant (NPDES Permit No. CA0109045, Order No. 2000-129) and one for the IBWC's International Wastewater Treatment Plant (NPDES Permit No. CA0108928, Order No. 96-50). Since the receiving waters monitoring requirements for both permits are essentially the same, approval of this resource exchange will apply towards both MRPs.

General Approach

A two-phased approach is proposed to create scientifically defensible maps of the San Diego region. The first phase (Phase 1) will focus on understanding spatial variability in the areas of interest. Once the spatial variability is known, then sampling distances (also known as lag distances) will be optimized for the second phase (Phase 2), where sampling will be conducted to create maps of specific areas and parameters. The focus of this workplan will be on the Phase 1 study. A detailed amendment to the workplan will be added for Phase 2 of the project once Phase 1 is completed.

In order to understand the spatial variability in an area of interest, one needs to plot one-half the variance (gamma) against a series of fixed distances. This type of plot, commonly referred to as a variogram (**Figure 1**), is the key element for determining the optimal lag distances for creating a map using kriging. The variogram has three reference points known as the nugget sill, and range.

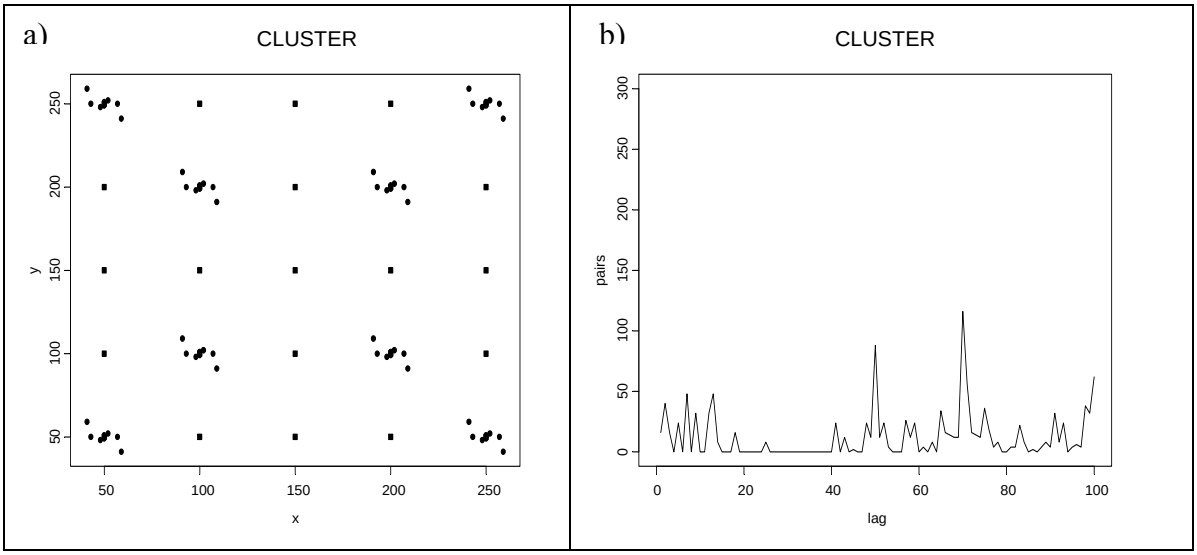
FIGURE 1. Example variogram.



The nugget indicates the variability between samples taken at very close proximities and represents both laboratory measurement error plus small-scale spatial variability. The sill is the variability achieved between samples spaced sufficiently far apart that a spatial relationship no longer exists. In this sense, the sill provides a measure of variability among spatially independent samples. The range is the lag distance at which the sill is achieved and provides the extent of the spatial relationships between sample points.

The primary focus of Phase 1 is to generate sufficient information to create variograms in the areas of interest. This requires sampling a large range of lag distances from the nugget, past the range, to the sill. Ideally, samples will be focused between the nugget and sill in order to best define the shape of the variogram curve. In order to generate these data, several clusters of sites will be sampled at multiple locations throughout the mapping areas. Clusters can be placed on top of existing grid sites to promote efficiency. S-shaped or more complex multi-lag clusters (i.e., overlapping S-clusters) provide tremendous value since they cover a large range of lag distances (e.g., **Figure 2**).

FIGURE 2. Hypothetical S-shaped cluster design (a) and frequency histogram of lag distances generated with this design (b).



Specific Approach

Multi-lag sampling design

We will create variograms for sediment condition in two main areas offshore San Diego: (1) centered around the Point Loma Ocean Outfall; (2) centered around the South Bay Ocean Outfall. Sets of multi-lag clusters will comprise the bulk of the sample sites and will be placed in regions surrounding both outfalls, while additional spatial coverage will be provided by sampling regular NPDES-mandated grid sites in both areas (**Figures 3-5**).

FIGURE 3. Overview of proposed site distribution for San Diego sediment mapping study; blue circles = new mapping sites, black circles = current or old NPDES grid stations, red circles = cluster enhancement areas representing 3-5 sites, 50-m lag distances apart (see Figures 4 and 5 for details).

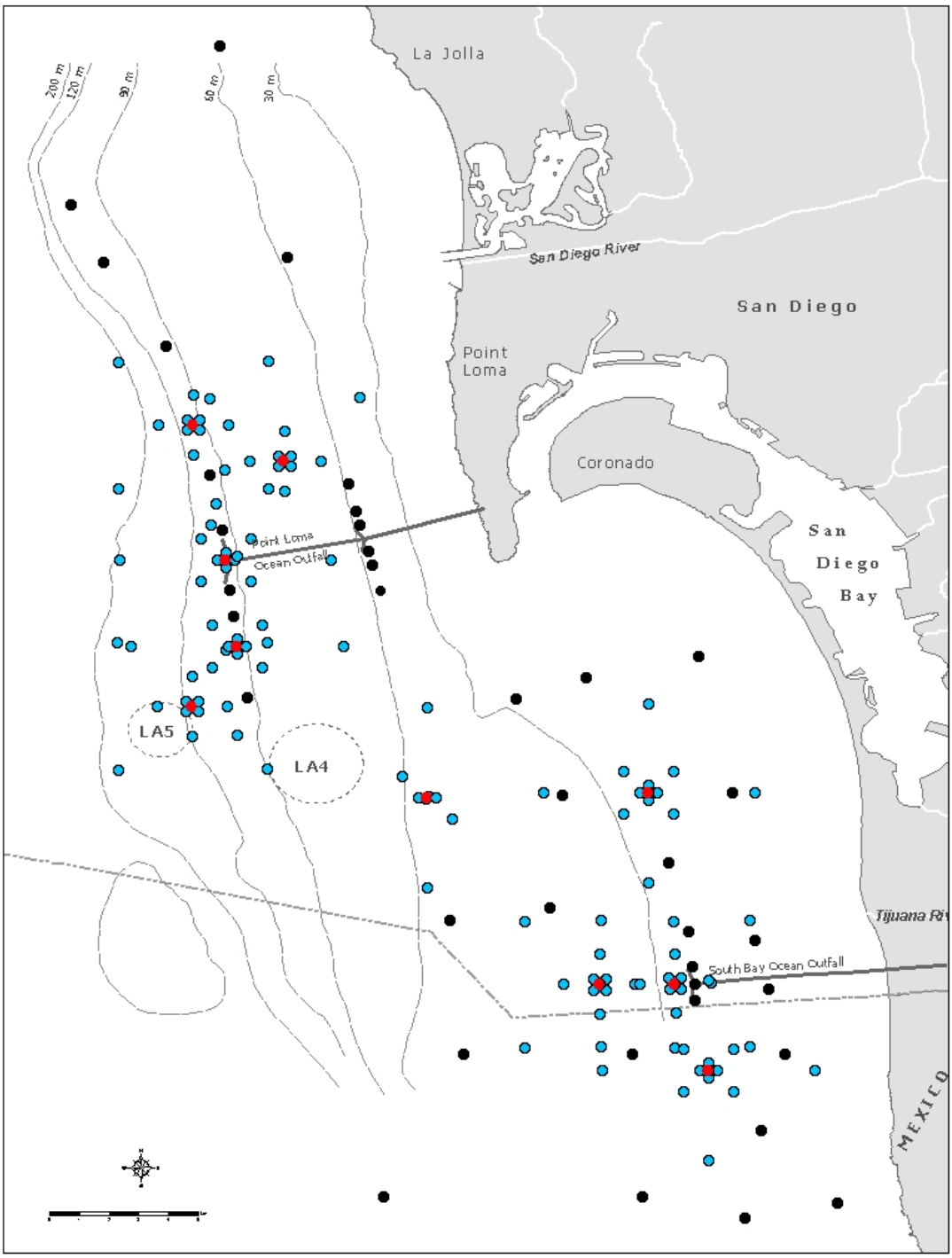


FIGURE 4. Expanded view of proposed site distribution for Point Loma outfall mapping region showing location of multi-lag clusters (five of size n = 17); blue circles = new mapping sites, black circles = current NPDES 98-m grid stations or old NPDES stations along inshore 60-m depth contour, red circles = cluster enhancement areas representing five sites each, 50-m lag distances apart (1 grid or new station in center + 4 new sites).

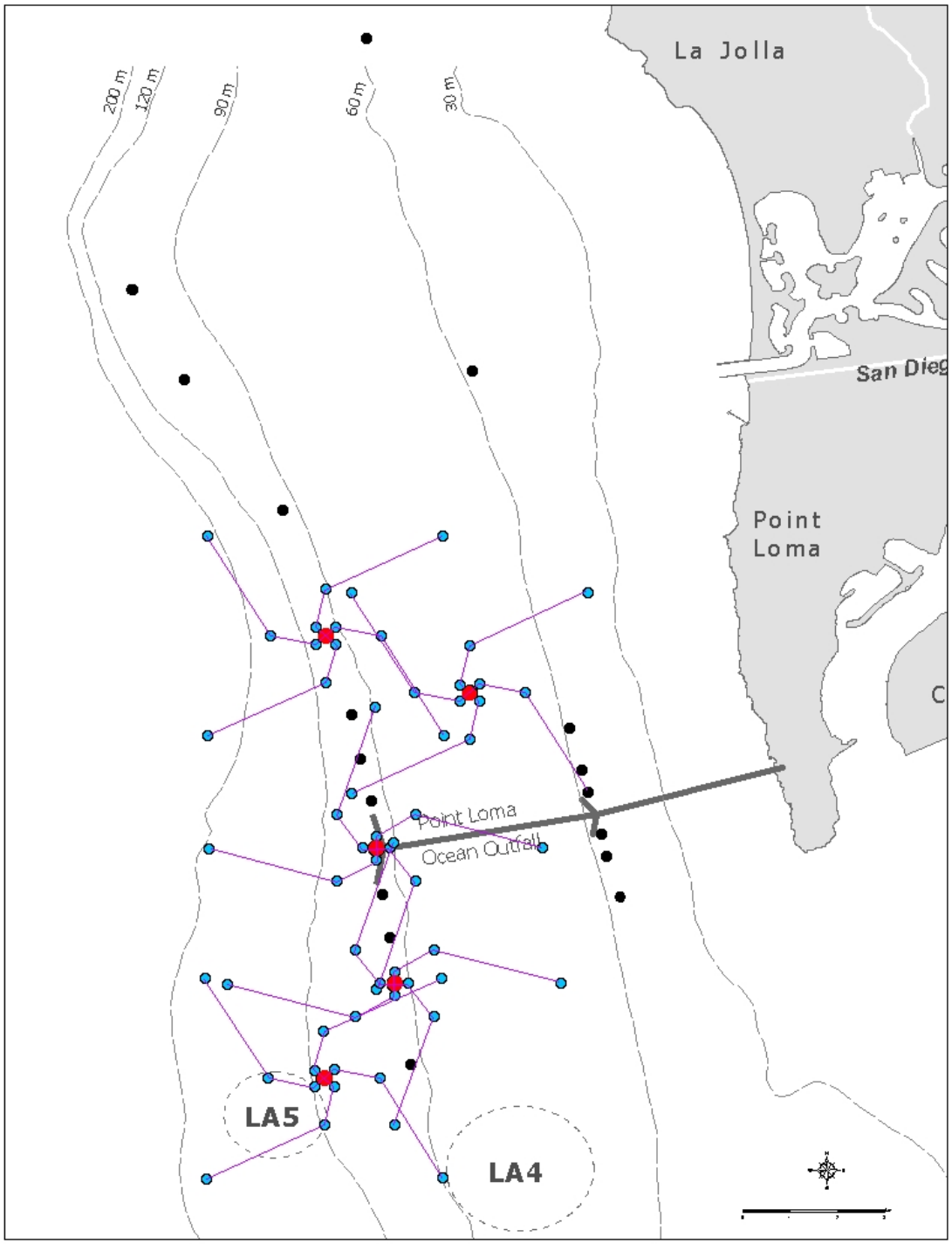
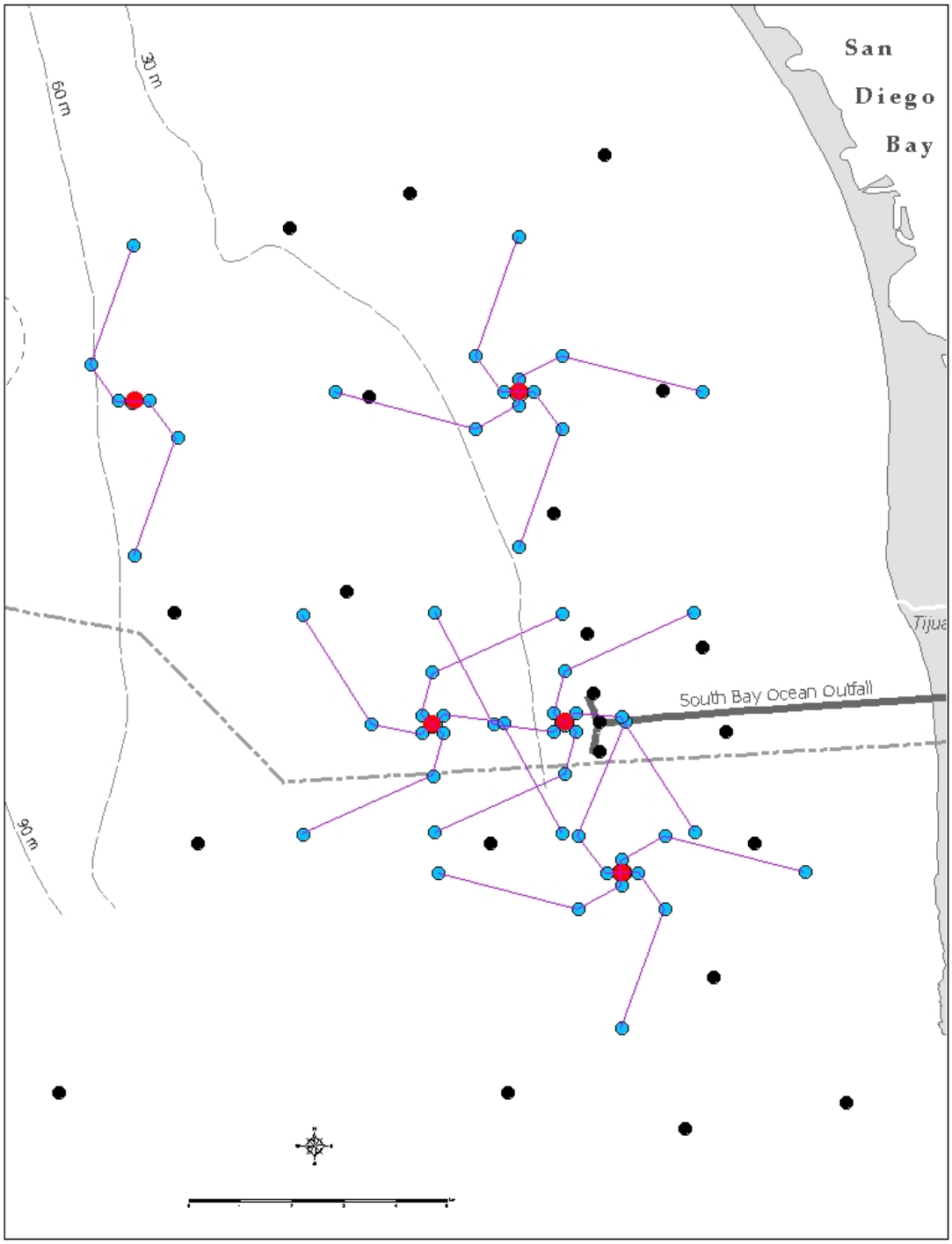


FIGURE 5. Expanded view of proposed site distribution for South Bay outfall mapping region showing location of multi-lag clusters (four of size n = 17, one of size n = 9); blue circles = new mapping sites, black circles = NPDES grid stations, red circles = cluster enhancement areas representing either three sites (1 grid station between 2 new sites) or five sites (1 grid station in center + 4 new sites), 50-m lag distances apart.



The two sampling areas encompass different types of soft bottom habitats that may have different spatial variance structures. Off Point Loma, we will include clusters centered near the existing discharge/diffuser site (depth ~100 m), at locations both north and south of the outfall, in shallower waters between the current and old (~60 m) outfall diffusers, and in an area bordering the LA-5 dredged materials disposal site located down coast and offshore of the outfall. Targeted areas for cluster placement in the South Bay region include near the present outfall diffusers (depth ~30 m), in slightly deeper waters west and north of the discharge site, and at several other locations north and south of the outfall.

Approximately 112 mapping samples will be collected for both sediments and animals (macrofauna) from sites located in the vicinity of the Point Loma Ocean Outfall, and about 107 samples will be collected from sites surrounding the South Bay Ocean Outfall (**Table 1**). Twelve of the sites near the Point Loma Ocean Outfall will be allocated to the primary core stations designated for the existing outfall monitoring grid, while eight sites will correspond to stations sampled previously along the original inshore discharge depth contour. The remaining sites/samples will be allocated among five multi-lag clusters. Twenty-seven of the sites near the South Bay Ocean Outfall will be allocated to the existing monitoring grid. The remaining 80 sites/samples will be allocated to the multi-lag clusters. About 10% of the samples will be designated as field duplicates to help derive the variogram nugget, thus reducing the total number of distinct sites sampled. A summary of the multi-lag cluster designs for both Point Loma and South Bay studies is presented in **Table 2**.

TABLE 1. Proposed sampling effort for Phase 1 of the sediment mapping study for both the Point Loma and South Bay outfall regions.

Sample Type	Number of Samples		
	Regular NPDES grid sites*	New mapping sites†	Total number of samples
Point Loma			
sediment	12	100	112
macrofauna	12 (24)*	100	112 (124)*
South Bay			
sediment	27	80	107
macrofauna	27	80	107

* Regular NPDES sites for Pt Loma = I° core stations currently monitored along the 98-m discharge depth contour; sampling at these 12 sites will include two replicate macrofauna grabs per NPDES permit requirements.

† Included as "new" mapping sites off Pt Loma are the locations of: (a) one II° core station currently monitored along the 116-m depth contour, and (b) eight old inshore stations located along the original 60-m discharge depth contour.

TABLE 2. Detailed sample distribution for Point Loma and South Bay mapping designs.

Site/sample distribution	Distinct # samples
Point Loma	(n = 112)
5 multi-lag clusters of size 17 < 5 enhancement areas (n = 5 sites)	85
13 NPDES grid sites (98-116 m) < stations E5, E14, E25 = enhancement centers (98 m) < station E3 = enhancement center (116 m)	9
8 inshore outfall sites (60 m) < station A16 = inshore edge of multi-lag cluster	7
11 field duplicates < enhancement centers + 6 sites to be determined	11
South Bay	(n = 107)
4 multi-lag clusters of size 17 < 4 enhancement areas (n = 5 sites)	68
1 multi-lag cluster of size 9 < 1 enhancement area (n = 3 sites)	9
27 NPDES grid sites < stations I9, I13, I15, I28, I30 = enhancement centers	22
8 field duplicates < enhancement centers + 3 sites to be determined	8

Sampling and analysis

At each monitoring site, benthic samples will be collected using a 0.1 m^2 chain-rigged VanVeen grab sampler. One sediment grab and one macrofauna grab will typically be collected at each site. However, if designated as a "field duplicate" site, two sediment and two macrofauna grabs will be collected. Differential global positioning (dGPS) will be used for navigation, and the final sampling location will be recorded for each site at the time the grab hits bottom. All samples will be collected and processed according to existing protocols. Sediment samples from the new mapping sites will be processed according to procedures (e.g., holding times, target analyte list) established for the Southern California Bight 2003 Regional Monitoring Project (e.g., Bight'03 Coastal Ecology Committee 2003), while samples from regular grid sites will be processed following the protocols specified in the appropriate NPDES permits (see City of San Diego 2004a, b). All sediment samples will be analyzed for grain size, total organic carbon, total nitrogen, trace metals, chlorinated pesticides, and polychlorinated biphenyl compounds (PCBs). The Bight'03 target list of metals, pesticides and PCBs for analysis of samples from the new mapping sites is specified in **Table 3**. In addition, samples collected for benthic community assessment will be sorted into major taxonomic groups (e.g., polychaetes, crustaceans, mollusks, echinoderms, other phyla combined), identified to the lowest taxon possible, and enumerated. Community assessment for each site will include calculation of total abundance, species richness (number of species), species diversity, dominance, and the benthic response index (BRI).

TABLE 3. Bight'03 target list of trace metals, pesticides and PCBs for sediment analyses (see Bight'03 Coastal Ecology Committee 2003).

Trace Metals	Pesticides	PCBs	
Aluminum	4,4'-DDT	PCB-18	PCB-128
Antimony	2,4'-DDT	PCB-28	PCB-138
Arsenic	4,4'-DDD	PCB-37	PCB-149
Barium	2,4'-DDD	PCB-44	PCB-151
Beryllium	4,4'-DDE	PCB-49	PCB-153
Cadmium	2,4'-DDE	PCB-52	PCB-156
Chromium	α-Chlordane	PCB-66	PCB-157
Copper	γ-Chlordane	PCB-70	PCB-158
Iron		PCB-74	PCB-167
Lead		PCB-77	PCB-168
Mercury		PCB-81	PCB-169
Nickel		PCB-87	PCB-170
Selenium		PCB-99	PCB-177
Silver		PCB-101	PCB-180
Zinc		PCB-105	PCB-183
		PCB-110	PCB-187
		PCB-114	PCB-189
		PCB-118	PCB-194
		PCB-119	PCB-201
		PCB-123	PCB-206
		PCB-126	

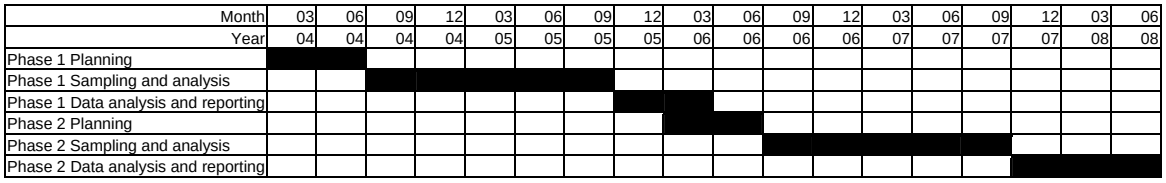
Products

The main product from Phase 1 of the mapping study will be a final report. This report will include: 1) a description of sampling success including sampling dates, times and locations; 2) summary tables of sediment condition including results from laboratory analysis; 3) descriptions of benthic community assemblages; and 4) variograms of sediment condition for chemical and biological parameters. Empirical variograms will be generated separately for the Point Loma and South Bay outfall areas, and then compared to determine the differences in spatial variance structures between the regions and/or habitats. Finally, a translation curve will be created using the empirically derived variograms that describe sampling lag distances versus relative confidence in prediction accuracy. This curve will be the focal point for Phase 2 of the mapping study, whereby we set lag distances for creating the final maps of sediment condition in the San Diego region.

Schedule

This project will take at least 54 months to complete (**Figure 6**). The first six months was used for assessing the appropriate sampling design for Phase 1 and drafting the overall workplan included herein. Upon approval of the workplan, approximately 15 months of sampling, and sample processing and analysis will be required for the Phase 1 study. Phase 1 data analysis and reporting will require another estimated six months, but may overlap with Phase 2 planning in order to increase efficiency. Phase 2 sampling and analysis will then require another 15 months, followed by about nine months of data analysis, reporting, and map-making. Project completion for Phase 2 is scheduled for June 2008. Although the Phase 2 study is mandated for the Point Loma region, additional negotiations and resource exchange agreements will be required for a Phase 2 study of the South Bay outfall region.

FIGURE 6. Tentative schedule for Phase 1 and 2 of San Diego mapping study.



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